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O.W.R.C.
Water Pollution
Survey

THE
ONTARIO WATER RESOURCES
COMMISSION

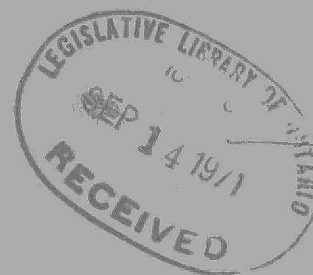
WATER POLLUTION SURVEY

of the

TOWN OF AURORA

COUNTY OF YORK

1971



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REPORT
ON A
WATER POLLUTION SURVEY
OF THE

TOWN OF AURORA
COUNTY OF YORK

August 1971

Division of Sanitary Engineering
District Engineers Branch

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R E P O R T

THE ONTARIO WATER RESOURCES COMMISSION

INTRODUCTION

This survey is an assessment of the water quality within the Town of Aurora. Surveys of this nature are made by the Ontario Water Resources Commission for the purpose of recording general water quality in a municipality as well as locating present and potential water pollution problems.

Field work for this survey was done during May, 1970 and February and March, 1971. As a comparison samples taken during 1967 and later have also been compiled which may assist in evaluating water quality.

I SUMMARY AND RECOMMENDATIONS

The activated sludge sewage treatment plant has little reserve hydraulic capacity and additional treatment units are required. This matter has been discussed with council and the Town Engineer has been asked to prepare a proposal on additional treatment units.

Water for the town is supplied by four well fields with the majority of the water being furnished by the Aurora Heights Field. The capacity and storage of the present system are approximately 3.5 MGD and 1,006,000 gallons respectively.

There are three industries in the town whose wastes could have an adverse effect on the treatment process at the town's sewage treatment plant unless strict attention is paid to their respective pre-treatment, and the effluents from the industries are controlled by a good by-law and vigorous enforcement of same.

Subdivision development in Aurora has almost reached a point where the reserve capacity of the sewage treatment plant is exhausted. Before the OWRC can give a favourable comment on any additional plans of subdivision, improved treatment and increased capacity plans for the sewage treatment plant will have to be at the stage where

contracts have been let.

The samples of Tannery Creek and its tributaries collected during 1970 and 1971 were generally of better quality than samples collected in 1967 and earlier.

The results of samples taken downstream of the sewage treatment plant indicated high BOD, solids and coliform counts because of the bypassing from the overloaded sewage treatment plant prior to 1968. At present, bypassing does occur during periods of heavy rainfall or runoff. It should be noted that approximately 65 percent of the sewerage system in Aurora is combined.

In previous years and during the recent sampling high BOD and coliform counts were evident between Tyler and Kennedy Streets, east and west of Yonge Street. This area is located in the older part of town and therefore should be checked for illegal connections and/or discharges to streams.

Recommendations

1. As recommended in the OWRC report entitled "A Water Use Study of the Holland River Basin (1969)" no more than 300 pounds of BOD per day should be

discharged from the sewage treatment plant to the Aurora Creek. If a limit of 10 ppm BOD was maintained this would mean that a maximum of 3.0 MGD could be discharged. Expansion and alterations would have to be made to the sewage plant before such flows could be accepted. The treatment at the plant should be improved to reduce the BOD input to the stream within the above limit.

2. Industrial discharges should be controlled by a good sewer-use by-law and enforcement programme. This is the town's responsibility.

3. A report should be prepared by the Town Engineer on a sewer separation programme. It is unlikely that storm tanks would be of much use as recent observations indicated bypassing during spring runoff of up to 0.5 MGD.

4. Residents should be advised that all sump pump systems should not be used to discharge sanitary wastes to a creek or ditch.

5. The watercourses in the town should be cleared of refuse to improve both the drainage and the aesthetic qualities.

6. The town should commission its consulting engineer to draw up detailed sewer plans.

II GENERAL

The Town of Aurora is located on Highway 11 approximately twenty-six miles north of Metropolitan Toronto. Since 1957 Aurora has increasingly become a part of the Metropolitan Toronto urban-rural fringe. In the ten years between 1957 and 1967 the Town of Aurora's population rose from 3,988 to 10,137. During this period there was unprecedented residential subdivision growth. The 1969 population was 10,891.

Land within the town is drained by the Aurora Creek and its tributaries. The entire built-up area of the town is serviced by municipal water and only a few homes are without municipal sanitary sewers. Approximately 65 percent of the sewers are combined sanitary and storm sewers.

III SEWAGE TREATMENT

Prior to 1967 the plant was designed for a 1.0 MGD flow providing complete treatment using the conventional activated sludge process. Due to the fact that the plant was hydraulically overloaded and bypassing of raw sewage occurred frequently, the plant was altered in 1968. The altered plant was designed for 1.8 MIGD (dry weather flow) and a BOD loading of 3,000 pounds. The plant was to use the contact stabilization process and chlorination of the final effluent.

A Holland River Basin report published in 1969 by OWRC states that the BOD loading to Aurora Creek from the sewage treatment plant should not exceed 300 pounds per day to ensure acceptable water quality in the stream. Previous reports by the OWRC staff has estimated that the plant discharges about 450 pounds of BOD to the stream per day. Before the plant was altered and severe bypassing was occurring, as much as 600 to 700 pounds of BOD was reaching the creek. Even though the alterations made to the sewage treatment plant were an improvement the creek does not have the ability to absorb the present waste loading, a fact which is fairly

evident both by visual inspection and comparison of sample results upstream and downstream from the plant. When assessing the adequacy of a sewage treatment plant there are three things to consider; hydraulic load, the organic load and the receiving stream conditions. In the case of Aurora downstream samples confirm the deterioration of water quality in Aurora Creek.

During 1970 the Technical Advisory Services Branch of the OWRC studied the contact stabilization process at Aurora. They operated the plant as a conventional process during the study and recommended that this method of operation continue, as a better effluent quality was achieved.

It has been recommended that changes be made at the plant to allow it to be operated as a conventional activated sludge process as well as the contact stabilization modification. This can be done by relatively minor expenditure on piping.

The town's consulting engineer has been instructed to prepare a proposal for improved treatment at the plant, one of the results should be the reduction of BOD to the stream within the limit of 300 pounds per day. Recently the town has been informed that it must provide for phosphorus removal of at least 80 percent at the sewage treatment plant by 1973.

IV PLANT OPERATION

From thirteen samples of the final effluent submitted during 1969 the BOD concentration of the final effluent exceeded 15 ppm 54 percent of the time and 10 ppm was exceeded 78 percent of the time. The suspended solids concentration exceeded 15 ppm ninety-two percent of the time and was never below 10 ppm. The average BOD and suspended solids of the raw sewage was 207 ppm and 359 ppm respectively. Composite samples taken on May 12, 1970 before the study by the Technical Advisory Services Branch indicated a final effluent BOD concentration of 50 ppm and a suspended solids concentration of 65 ppm. The effluent is not satisfactory.

During 1968 the average flow at the plant was 2.8 cfs or 1.51 MGD. This represents a flow per capita of 160 gallons. In 1969 the flow meter was removed for alterations. An estimate of the average flow for 1969, using a figure of 160 gallons per capita is 1.7 MGD.

In 1970 the average daily flow was approximately 1.6 million gallons per day. The average daily per capita flow appears to be 132 gallons which is based on a population of 11,391.

V DISCUSSION

At present, difficulties are being experienced with the final clarifiers, particularly during the peak daily flows, because of hydraulic overload. The north aeration tank overflows when the rate of flow exceeds 2.5 to 2.75 MGD, this also places a limitation on the hydraulic capacity of the plant. During peak flows in dry weather conditions there is very little freeboard at the inlet works and it would take very little extra loading to cause a bypass of raw sewage to the creek.

From early March to mid-April bypassing was necessary at the plant due to the spring runoff. The old aeration section of the plant which has been proposed as a storm tank was of little value during this time as it filled in about 1.25 hours. It was not possible to pump at rates much above 2.75 MGD as this caused overflows at the aeration tank and further aggravated the hydraulic overload on the final clarifiers.

Comparison of flows on weekends in dry weather and during the spring runoff indicates that quantities of runoff up to 750,000 gallons/day could be entering the sewer system. It would appear that the ultimate

solution is an entirely separate system of storm and sanitary sewers.

A good sewer use bylaw and a vigorous enforcement programme are also essential if shock loads are to be eliminated from the plant.

VI MUNICIPAL WATER SUPPLY

(a) Aurora Heights Well Field

At present this well field consists of three deep drilled wells. Two wells supply the majority of the water, reportedly a total of 2,200 gpm. The third well is capped and should be placed in operation during this summer when pumping facilities are completed.

(b) Water Works and Billings Well Field

The Water Works well field consists of two, three-inch wells with air lifts and the Billings well field contains three, four-inch and two, two-inch flowing wells. All of these wells discharge to two underground reservoirs at the police station and then the water is pumped to the distribution system.

In past years, it has been estimated that these two well fields can supply a total of 210 gpm although there have been no recent measurements made.

(c) Nisbet Well Field

This supply consists of six, two-inch flowing wells with a capacity of 100 gpm. Due to the very high iron content of the water this supply is only used during peak demand during the summer months.

The storage for the system at present totals

1,006,000 gallons comprised of the following components.

Regency Acres Elevated Tank	500,000 gals.
Standpipe East Yonge Street	210,000 gals.
Water Works Pumping Station	<u>296,000 gals.</u>
	1,006,000 gals.

A new 1.5 MGD underground reservoir which is to be located in the north-west section of town is proposed. When the underground reservoir is completed the total storage will be 2,506,000 gallons. In addition to the above storage there is a 33,000 gallon and a 9,000 gallon pumpwell at the Aurora Heights and Nisbet Well Fields.

VII CAPACITY AND PUMPAGES

The instantaneous pumpage rate of the system is 2,925 gpm, however, because of the poor quality of water from Nisbet wells this supply is rarely used resulting in an instantaneous pumpage rate of 2,700 gpm. The present capacity of the well fields is approximately 3.5 MGD.

In the past only the water from the Aurora Heights pumphouse was metered, however, recently a time clock has been installed at the Water Works pumphouse to indicate the pumpage. Since the pumpages from the Water Works well field have only recently been recorded and no records of pumpage from the Nisbet wells are maintained pumpages can only be estimated. The maximum and average pumpages appear to be 3.4 million gallons and 1.4 million gallons respectively.

In the town there are approximately thirty-one metered industrial services with the remainder of the town being on a flat rate.

VIII WATER QUALITY

The water from all the well fields is hard and has a high iron content. The iron concentration in the water is consistently above 0.3 ppm. Because of this high iron content a programme of main flushing and swabbing has had to be initiated.

Also due to the high iron concentration it is not possible to chlorinate the water without installing some additional treatment to prevent the iron precipitating in the distribution system. During 1969, 12 percent of the bacteriological samples contained coliform bacteria of which 12.5 percent of these contained fecal colforms. These fecal coliform counts can possibly be attributed to poor sampling techniques or the conditions of the surroundings in which the samples were taken. In 1970, eighty-one samples were collected and nine or 11.1 percent of these were adverse.

IX IMPROVEMENTS TO SYSTEM

A new sixteen-inch, deep, drilled well is being developed at Aurora Heights Well Field. The new well has a capacity of 1,500 gpm and plans call for it to be pumped at 1,200 gpm.

Also planned is a 1.5 million gallon underground reservoir to be located in the north-west section of town.

Tests on the Aurora well water were made by the Technical Advisory Services Branch of the OWRC to determine the feasibility of using silica (as SiO_2) and chlorination to prevent the precipitation of iron in the distribution system. The results of the tests were satisfactory. The plans for the addition of sodium silicate have been prepared by the town's consulting engineer and have received formal approval from the OWRC. Therefore, this equipment should now be installed without delay.

The progress that the town has made in its programme of improving the water supply and quality is commendable.

X INDUSTRIES

(a) Checkerboard Farms Limited

The original agreement that Checkerboard Farms (Ralston Purina Company) made with the town allowed for the discharge of 52,000 Imperial gallons of waste daily to the municipal sewerage system. The wastes strength was not to exceed 300 ppm BOD or 350 ppm suspended solids. Waste flows of 150,000 gallons per day were common and the waste strength was in the range of 800 ppm BOD.

It has been reported that this chicken abattoir can process a maximum of 80,000 birds during two eight hour shifts. Therefore, providing there was no plant expansion a water use of 300,000 gallons daily was foreseen to process birds at a maximum production.

Facilities for pre-treatment of waste have been completed at Checkerboard Farms. The method of pre-treatment is extended aeration and preliminary samples have indicated a reduction from a raw sewage level of 1,000 ppm BOD to a final effluent of 150 ppm BOD. This plant will no doubt do better than this when some operating experience has been gained.

The town and the industry have shown a

creditable willingness to face up to this problem and affect a solution; however, an agreement should be drawn up to spell out clearly the flow, BOD and solids limits which the industry has to meet.

(b) Collis Leather

All contaminated wastes from the company are discharged to the sanitary sewer while uncontaminated cooling water is directed to the storm sewer. Plant wastes are subjected to equalization followed by aeration and settling. The overflow from the settling tank discharges to the sanitary sewers. The treated effluent varies in its quality and this is noticeable at the sewage treatment plant.

(c) Aluminum Company of Canada

During May, 1970, Alcan was making alterations to their processes. This work caused an abnormal carry over of solids into the sanitary sewer. Also low and high pH values were caused by the spillage of an acid container and the caustic used to neutralize it.

The effluent from this industry also varies in quality and at times the incoming sewage is coloured whitish-grey by a flocculant material. Samples of the effluent from Alcan also tend to form the same whitish-grey

floc. The whitish-grey colour persists to the final effluent of the plant.

As indicated before the control of discharges to sewers can only be exercised through a good sewer-use bylaw and a vigorous enforcement programme. This is the town's responsibility.

XI DEVELOPMENT

Since August, 1968, seven draft plans of proposed subdivisions have been submitted to the Department of Municipal Affairs. The seven subdivisions could increase the population of Aurora by over 5,000 people if all the subdivisions got final approval. To date only one plan consisting of 298 lots for single family dwellings has received final approval.

The town has been notified by OWRC that there is hydraulic capacity at the sewage treatment plant for approximately 750 persons.

XII SAMPLE RESULTS AND OBSERVATIONS

Samples taken from Aurora in 1964, 1967, 1970 and 1971 have been compiled and are appended to this report. Generally, samples taken during May, 1970 and March, 1971 showed better quality than samples taken in previous years. Several adverse samples were collected, however, and these are noted.

Samples taken of the Aurora Creek downstream from the sewage treatment plant range widely in BOD and suspended solids concentrations, e.g., 10 ppm to 50 ppm. Upstream from the plant the BOD and suspended solids concentrations were generally within 3.0 ppm and 15 ppm respectively. The coliform counts upstream were usually higher than downstream coliform counts. The decrease in coliform bacteria can be attributed to disinfection properties of the chlorine being added to the final effluent of the treatment plant. The high BOD and suspended solids loading from the sewage plant on the river is evident from upstream and downstream samples.

It appears that some outfalls which empty into Aurora Creek or its tributaries are used for sewage relief overflow. This is not surprising when you consider that approximately 65 percent of the sewerage system in Aurora is combined.

The bacteriological sample results taken in 1967 from HOA-19.85W and HOA-20.33W were very high in total coliforms, e.g. 51,000,000 MG/L and 15,300,000 MG/L. The results of samples taken from the same outfall in 1971 were considerably lower (e.g. 6,800 MG/L and 9,800 MG/L). One reason for the lower total coliform counts this year could possibly be attributed to the dilution of the raw sewage by the heavy spring runoff. Another reason could be that the town has made improvements to these outfalls with regard to relief overflow.

Two outfalls HOAT-20.67W and HOA-19.6W(E) both had high total and fecal coliform counts when sampled this year. The contaminating flows from these outfalls should be traced and then corrected.

A private drain designated as HOA-20.2P was discharging wastes to the creek apparently by a sump pump system from a Temperance Street house. The wastes had a BOD concentration of 28.0 ppm and 1,100,000 coliform organisms per 100 ml were noted. The effects of this discharge was noted in two downstream samples designated as HOA-20.2 and HOA-20.00. The upstream sample was of significantly better quality. This problem has been corrected and only ground water is pumped to the creek.

A watercourse behind the shopping centre
at the junction of Yonge Street and Murray Drive was
littered with debris, ie., cartons, cans and bottles.



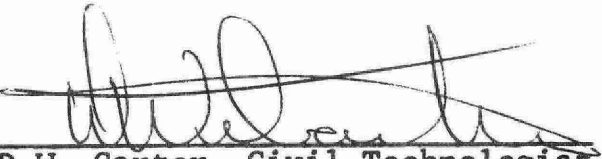
Behind the building owned by Lawton Brothers Limited on Yonge Street there was an area of oil saturated soil which appears to be the result of spillage from abandoned oil containers. Although no oil was entering the watercourse during the time when samples at HOAT-21.1P were taken, this could be a problem during heavy rains and during the spring.

At sampling point HOAW-21.20, garbage and debris had collected in the water causing the creek to become stagnant.

At sampling point HOA-20.00 debris was also noted on the banks and in the water. Although this debris did appear to be affecting the flow of the creek, it should be cleaned to maintain the aesthetic quality of the watercourse.

Another part of Tannery Creek north of St. Andrew's College entrance was blocked with tree branches, and other material. These blockages should be cleared to allow free flow in the stream.

Prepared by:


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/cs

TOWN OF AURORA

AURORA CREEK ANALYTICAL RESULTS

TABLE I

SAMPLING POINT NO.	DESCRIPTION	DATE	5-DAY BOD (ppm)	SOLIDS		COLIFORMS PER 100 ML	
				TOTAL (ppm)	SUSP. (ppm)	TOTAL	FECAL
HOA-18.5	Aurora Creek at St. Johns Sideroad.	Nov. 18/64	14	816	14	35,000	-
		Mar. 29/65	10	660	27	43,000	-
		Apr. 10/67	14	592	43	1,030,000	-
		Sept. 26/67	3	614	35	63,000	-
		Mar. 24/71	14	780	50	4	4
HOA-19.3	Aurora Creek at Yonge Street North.	Nov. 18/64	26	1006	51	29,000	-
		Apr. 10/67	19	524	24	900	-
		Sept. 26/67	37	974	-	49,000,000	-
		May 14/70	11	750	40	10	10
		Mar. 24/71	-	-	-	10	4
HOA-19.6	Aurora Creek down- stream from STP Outfall.	Nov. 18/64	26	1016	46	40,000	-
		Mar. 29/65	18	784	41	1,690	-
		Apr. 11/67	10	672	52	170	-
		Sept. 26/67	43	686	65	10,800,000	-
		May 12/70	7.0	800	40	4	-
		May 14/70	9.0	740	40	4	4
		Mar. 24/71	9.0	760	80	740	28
HOA-19.8	Aurora Creek up- stream from STP Outfall.	Nov. 18/64	2.1	392	7	160,000	-
		Mar. 29/65	2.5	604	29	89,000	-
		Apr. 11/67	0.6	448	12	14,000	-
		Sept. 26/67	1.5	386	16	34,000	-
		May 12/70	0.2	380	15	670	2

TABLE I (CONTD)

SAMPLING POINT NO.	DESCRIPTION	DATE	5-DAY BOD (ppm)	SOLIDS		COLIFORMS PER 100 ML	
				TOTAL (ppm)	SUSP. (ppm)	TOTAL	FECAL
HOA-19.85	Aurora Creek at Foot of Irwine Avenue	Mar. 24/71	5.5	520	35	4,900	2,400
HOA-20.00	Aurora Creek at Wellington Street	Apr. 11/67	2.2	456	15	5,000	-
		Sept. 26/67	1.6	384	12	68,000	-
		May 14/70	1.8	360	10	4,900	2,340
		Mar. 24/71	-	-	-	17,900	3,500
HOA-20.16	Aurora Creek at Tyler Street	Mar. 24/71	-	-	-	2,700	256
HOA-20.20	Aurora Creek at Temperance Street	May 14/70	4.5	300	10	1,100	172
		Mar. 24/71	-	-	-	6,000	1,000
HOA-20.30	Aurora Creek West of Yonge Street	Mar. 24/71	-	-	-	4,000	1,200
HOA-20.31	Aurora Creek East of Yonge Street	Mar. 24/71	-	-	-	6,000	1,300
HOA-20.80	Dunning Avenue and Creek	Mar. 24/71	-	-	-	280	100
HOA-20.82	Creek South of Dunning Avenue	Mar. 24/71	-	-	-	284	128
HOA-20.9	Aurora Creek Upstream from Dunning Avenue	Nov. 19/64	0.6	312	13	7,000	-
		Mar. 29/65	1.1	398	30	66	-
		Apr. 27/67	-	-	-	156	-
		Sept. 27/67	-	-	-	530	-
		May 14/70	2.5	330	15	112	88

TABLE I (CONTD)

SAMPLING POINT NO.	DESCRIPTION	DATE	5-DAY BOD (ppm)	SOLIDS		COLIFORMS PER	
				TOTAL (ppm)	SUSP. (ppm)	100 ML TOTAL	FECAL
HOAE-20.76	Tributary at Edward Street	May 4/67	-	-	-	48	-
		Sept. 27/67	-	-	-	600	-
		May 14/70	1.0	390	10	4	4
		Mar. 24/71	-	-	-	180	48

TOWN OF AURORA

OUTFALLS TO AURORA CREEK ANALYTICAL RESULT

TABLE IA

SAMPLING POINT NO.	DESCRIPTION	DATE	5-DAY BOD (ppm)	SOLIDS TOTAL (ppm)	SUSP. (ppm)	COLIFORMS PER 100 ML	
						TOTAL	FECAL
HOA-18.8T	St. Andrew's College STP Final Effluent.	Nov. 18/64	9.2	370	39	2	-
		Mar. 24/71	7	560	40	8,100	244
HOA-19.5W	Storm Sewer Outfall to Aurora Creek at Aurora Heights Drive.	Apr. 10/67	2.0	416	8	32	-
		Sept. 26/67	2.1	556	58	4,800	-
HOA-19.6W(W)	24" Storm Sewer on West Side of Tributary.	May 14/70	8	420	5	1,000	244
HOA-19.6w(E)	24" Storm Sewer on East Side of Tributary.	May 14/70	1.8	780	10	1,200	188
		Mar. 24/71	-	-	-	14,900	8,300
HOA-19.7D-1	Ditch Draining to East Bank.	Apr. 11/67	1.8	664	13	15,400,000	-
HOA-19.7T-2	New Aurora STP Final Effluent (C1)	Nov. 23/64	4.0	1680	58	90,000	-
		Sept. 26/67	22	1360	64	4	-
		May 14/70	17	1200	75	4	4
HOA-19.7W	Storm Sewer Outfall to West Bank.	Apr. 11/67	1.5	498	2	16	-
		May 14/70	0.6	610	5	4	4

TABLE IA (CONTD)

SAMPLING POINT NO.	DESCRIPTION	DATE	5-DAY BOD (ppm)	SOLIDS		COLIFORMS PER 100 ML	
				TOTAL (ppm)	SUSP. (ppm)	TOTAL	FECAL
HOA-19.7T-1	Old Aurora STP Effluent (C1)	Nov. 18/64	51	1400	59	48	-
		Apr. 11/67	10	1096	34	80,000	-
		Sept. 26/67	28	1360	142	10,600,000	-
HOA-19.85W	Storm Sewer Outfall at Foot of Irwine Avenue.	Apr. 11/67	2.1	712	9	50,000	-
		Sept. 26/67	19.0	380	18	51,000,000	-
		Mar. 24/71	-	-	-	6,800	1,200
HOA-19.95W	Storm Sewer at Foot of Wellington Street.	Apr. 11/67	6.8	454	118	272	-
HOA-20.1W	Storm Sewer Outfall to East Bank.	Apr. 10/67	1.9	806	54	210	0
HOA-20.16P	Outlet to West Bank just South of Tyler Street.	Apr. 12/67	14	340	38	16,000,000	-
HOA-20.16W	Outfall from East Bank, Tyler Street.	Mar. 24/71	-	-	-	2,100	100
HOA-20.2P	2" Plastic Private Drain	May 14/70	28	670	20	1,100,000	660
HOA-20.31W(N)	Storm Sewer Outfall to Aurora Creek North Side of Yonge Street	Apr. 12/67	2.9	1036	5	28,000	-
HOA-20.31W(S)	Storm Sewer Outfall to Aurora Creek South Side of Yonge Street	Apr. 12/67	1.7	3734	6	7,400	-

TABLE IA (CONTD)

SAMPLING POINT NO.	DESCRIPTION	DATE	5-DAY BOD (ppm)	SOLIDS		COLIFORMS PER 100 ML	
				TOTAL (ppm)	SUSP. (ppm)	TOTAL	FECAL
HOA-20.33W	Outfall to Aurora Creek at Harrison Street	Apr. 27/67	138	1296	304	112,000,000	-
		Sept. 26/67	19	746	23	15,300,000	-
		Mar. 24/71	-	-	-	9,800	5,000
HOA-20.37P	Outfall to Creek Opposite Police Station	Apr. 27/67	46	1108	606	900	-
		Sept. 26/67	72	604	75	81,000,000	-
HOA-20.42W(W)	Storm Sewer Outfall	Apr. 27/67	0.8	614	2	8	0
		Mar. 24/71	-	-	-	180	68
HOA-20.42W(E)	Storm Sewer Outfall from Victoria Street	May 14/70	0.4	240	5	24	40
		Mar. 24/71	-	-	-	240	150
HOA-20.48W	Storm Sewer Outfall North of Cousins Drive	Apr. 27/67	2.6	856	35	960	-
HOA-20.6W	Outfall to Culvert at Cousins Drive	Apr. 27/67	0.9	652	4	930	-
		May 14/70	1.8	320	5	30	30
		Mar. 24/71	-	-	-	1,100	464
HOA-20.61W	Storm Sewer Outfall to Creek at Cousins Drive	Apr. 27/67	0.4	342	3	4	-
		Sept. 26/67	6.8	129	3	90	-
		May 14/70	3.5	340	5	4	4
		Mar. 24/71	-	-	-	1,600	24
HOA-20.82W	Storm Sewer Outfall	May 12/70	0.6	270	5	4	4
		Mar. 24/71	-	-	-	8	4

TABLE IA (CONTD)

SAMPLING POINT NO.	DESCRIPTION	DATE	5-DAY BOD (ppm)	SOLIDS		COLIFORMS PER 100 ML	
				TOTAL (ppm)	SUSP. (ppm)	TOTAL	FECAL
HOA-20.87D	Ditch Draining to Aurora Creek Behind Alcan	Apr. 27/67	4.3	496	5	124	-
HOAE-20.81P1	Outfall to Tributary Behind Excel Metal Craft Limited	Apr. 27/67	1660	14,850	4646	0	-
		Mar. 23/71	.4	250	5	4	4
HOAE-20.81P2	Outfall to Tributary Behind Excel Metal Craft Limited	Apr. 27/67	0.8	580	9	140	-
		Mar. 23/71	-	-	-	92	20

TOWN OF AURORA

WEST TRIBUTARY OF AURORA CREEK ANALYTICAL RESULTS

TABLE II

SAMPLING POINT NO.	DESCRIPTION	DATE	5-DAY BOD (ppm)	SOLIDS		COLIFORMS PER 100 ML	
				TOTAL (ppm)	SUSP. (ppm)	TOTAL	FECAL
HOAW-19.92	West Creek Above Confluence with Aurora Creek	Apr. 11/67	2	344	14	60	-
		Sept. 26/67	1.2	360	14	1,060	-
		May 12/70	1.2	360	5	800	24
		Mar. 24/71	-	-	-	1,800	276
HOAW-20.15	West Creek at Beginning of Harriman Road	Mar. 24/71	-	-	-	2,300	124
HOAW-20.3	West Creek at end of Harriman Road	Nov. 23/64	1.9	314	10	120	-
		Mar. 29/65	1.2	316	6	50	-
		Apr. 11/67	2.0	320	14	80	-
		May 12/70	1.2	340	5	330	48
		Mar. 23/71	-	-	-	1,600	168
HOAW-21.29	West Creek at end of Glass Drive	May 11/67	2.6	296	6	108	-
		Sept. 26/67	-	-	-	1,190	-
		May 12/70	1.0	330	5	12	4
HOAW-21.75	West Creek at Town Limits	Apr. 12/67	1.2	390	7	520	-
		May 14/70	1.6	270	10	4	4
HOAWW-20.16	Creek East of Heida Drive	Mar. 24/71	-	-	-	300	4

TABLE II (CONTD)

<u>SAMPLING POINT NO.</u>	<u>DESCRIPTION</u>	<u>DATE</u>	5-DAY BOD <u>(ppm)</u>	SOLIDS		COLIFORMS PER	
				<u>TOTAL (ppm)</u>	<u>SUSP. (ppm)</u>	<u>100 ML</u>	
						<u>TOTAL</u>	<u>FECAL</u>
HOAWW-20.2	Creek at Heida Drive	Mar. 24/71	-	-	-	336	220
HOAWW-20.35	West Branch of West Creek at McDonald Crescent	Apr. 11/67	1.6	278	6	190	-
		May 12/70	1.0	380	5	70	4

TOWN OF AURORA

OUTFALLS TO WEST TRIBUTARY ANALYTICAL RESULTS

TABLE IIA

<u>SAMPLING POINT NO.</u>	<u>DESCRIPTION</u>	<u>DATE</u>	<u>5-DAY BOD (ppm)</u>	<u>SOLIDS</u>		<u>COLIFORMS PER 100 ML</u>	
				<u>TOTAL (ppm)</u>	<u>SUSP. (ppm)</u>	<u>TOTAL</u>	<u>FECAL</u>
HOAW-20.25P	Drain from Private Pond	May 12/70	1.8	360	10	40	16
HOAW-20.3P	East Bank of Creek Harriman Road	Mar. 24/71	-	-	-	4	4
HOAW-21.25W	Storm Sewer Outfall	May 14/70	3.0	900	10	1,600	40
HOAW-21.3W	Storm Sewer Outfall	May 14/70	2.0	760	15	12	4
HOAWW-20.15P	Drain from Shopping Centre on Wellington Street	May 12/70	1.2	290	15	6,800	84

TOWN OF AURORA

CENTRE TRIBUTARY OF AURORA CREEK ANALYTICAL RESULTS

TABLE III

SAMPLING POINT NO.	DESCRIPTION	DATE	5-DAY BOD (ppm)	SOLIDS		COLIFORMS PI	
				TOTAL (ppm)	SUSP. (ppm)	100 ML TOTAL	FECAL
HOAT-20.17	Tannery Creek just above Confluence with Aurora Creek	Apr. 12/67	2.1	522	14	5,000	-
		Sept. 26/67	1.6	230	19	15,000	-
		May 14/70	2.0	430	25	1,900	68
		Mar. 23/71	-	-	-	8,200	3,000
HOAT-20.33	Tannery Creek at Reuban Street	Apr. 12/67	1.9	600	19	520	-
		Sept. 26/67	1.6	376	18	20,000	-
		May 14/70	2.5	370	15	8,600	950
		Mar. 23/71	4.0	590	30	1,000	120
HOAT-20.45	Tannery Creek just above Junction	Nov. 18/64	2.1	524	7	560	-
		Mar. 26/65	1.4	408	8	1,270	-
HOAT-20.5	Tannery Creek at Small Dam Behind Tannery	Nov. 18/64	1.4	518	6	560	-
		Mar. 23/71	2.0	590	15	500	200
HOAT-20.89	Creek Upstream from Golf Club Pond	May 12/70	0.4	330	10	360	20
		Mar. 23/71	-	-	-	76	16
HOAT-20.90	Tannery Creek at Brooklands Road	May 10/67	6.1	826	14	13,400	-
		May 12/70	1.6	410	10	450	104
		Mar. 23/71	-	-	-	20	4

TABLE III (CONTD)

SAMPLING POINT NO.	DESCRIPTION	DATE	5-DAY BOD (ppm)	SOLIDS		COLIFORMS PER 100 ML	
				TOTAL (ppm)	SUSP. (ppm)	TOTAL	FECAL
HOAT-20.97	Tannery Creek Approx. 250' South of Brooklands Road	May 12/70	0.6	330	10	80	80
		Mar. 23/71	-	-	-	90	4
HOAT-21.1	Creek Behind Lawton Brothers Ltd.	Mar. 23/71	-	-	-	20	4
HOAT-21.6	Tannery Creek at Town Limits	Apr. 12/67	1.2	508	8	120	-
		May 14/70	1.6	400	5	44	28

TOWN OF AURORA

OUTFALLS TO THE CENTRE TRIBUTARY ANALYTICAL RESULTS

TABLE IIIA

SAMPLING POINT NO.	DESCRIPTION	DATE	5-DAY BOD (ppm)	SOLIDS		COLIFORMS PER 100 ML	
				TOTAL (ppm)	SUSP. (ppm)	TOTAL	FECAL
HOAT-20.17W	Storm Sewer Outfall to West Bank at Front of Collis Leather	Apr. 12/67	49	1224	106	4	-
HOAT-20.24W	Outfall to West Bank Rear of Collis Leather	Apr. 12/67	4	724	28	50	-
		Sept. 26/67	14	658	164	120,000	-
		Mar. 24/71	-	-	-	80	4
HOAT-20.45W	Storm Sewer Outfall to East Bank at Kennedy Street	Apr. 12/67	1.4	686	2	830	-
		Mar. 24/71	12	750	230	360	40
HOAT-20.67W	Outfall near Nisbet Pumphouse	Mar. 24/71	-	-	-	130,000	29,000
HOAT-20.94W	12" Outfall Above Brookland Drive	Apr. 12/67	2.9	704	11	320	-
		Mar. 24/71	-	-	-	92	4
HOAT-20.95W	21" Outfall Above Brookland Drive	Apr. 12/67	2.2	402	7	180	-
		Sept. 26/67	0.3	348	3	44	-
		May 12/70	0.8	340	5	4	4
		Mar. 24/71	-	-	-	4	4
HOAT-21.10W	Outfall Behind Lawton Brothers Limited	May 14/70	0.4	250	5	4	4

TABLE IIIA (CONTD)

SAMPLING POINT NO.	DESCRIPTION	DATE	5-DAY BOD (ppm)	SOLIDS		COLIFORMS PER 100 ML	
				TOTAL (ppm)	SUSP. (ppm)	TOTAL	FECAL
HOAT-21.23W	Culvert Under Murray Drive	May 14/70	1.0	420	10	148	76
		Mar. 24/71	-	-	-	148	4
HOAT-21.38W	Outfall from Davis Drive	May 14/70	1.0	390	5	700	104
HOAT-21.39W	6" Outfall	Apr. 12/67	1.7	306	5	4	-
		May 14/70	0.8	400	5	104	68
		Mar. 24/71	-	-	-	0	4
HOAT-21.40P	2" Plastic Pipe	May 14/70	0.6	300	5	12	12

APPENDICES

WATER QUALITY AND EFFLUENT OBJECTIVES

The OWRC objectives for surface water is described in a booklet entitled "Guidelines and Criteria for Water Quality Management in Ontario." A copy of the booklet is enclosed in the pocket on the back cover of this report. This publication contains the guidelines and introduces water quality criteria for various uses including public, agricultural and industrial water supply, recreation, aesthetic enjoyment and the propagation of fish and wildlife. The guidelines should be followed to determine the acceptability of a watercourse for various uses.

GLOSSARY OF TERMS

Bacteriological Examinations - The Most Probable Number Technique is used by the Ontario Department of Health to obtain an approximation of the actual number of coliform organisms present. The Membrane Filter Technique is used by the OWRC to obtain a direct count of coliform organisms. These organisms are the normal inhabitants of the intestines of man and other warm-blooded animals. They are always present in large numbers in untreated sewage and are, in general, relatively few in number in other stream pollutants.

Biochemical Oxygen Demand (BOD) - The biochemical oxygen demand test indicates the amount of oxygen required for stabilization of the decomposable organic matter found in sewage, sewage effluent, polluted waters, or industrial wastes by aerobic biochemical action.

Solids - The analyses for solids include tests for total, suspended and dissolved solids. The total solids is a measure of the solids in solution and in suspension. Suspended solids indicate the measure of undissolved solids of organic or inorganic nature whereas the dissolved solids are a measure of those solids in solution.

SIGNIFICANCE OF LABORATORY ANALYSES

Bacteriological Examination - The presence of coliforms indicates pollution from human or animal excrement or from some non-faecal forms.

The OWRC Laboratories employ the Membrane Filter (MF) Technique of examination to obtain a direct enumeration of coliform organisms. The Department of Health Laboratories use the Most Probable Number (MPN) enumeration and coliform counts are reported as Total Coliform Organisms (TC) and Fecal Organisms (FC).

Sanitary Chemical Analyses

Biochemical Oxygen Demand (BOD) - Biochemical Oxygen

Demand is reported in parts per million (ppm) and is an indication of the amount of oxygen required for the stabilization of decomposable organic or chemical matter in water. The completion of the laboratory test requires five days, under the controlled incubation temperature of 20° centigrade.

The OWRC objective for surface water quality is an upper limit of four (4) ppm.

Solids - The value for solids, expressed in parts per million, is the sum of the values for the suspended and the dissolved matter in the water. The concentration of suspended solids is generally the most significant of the solids analyses with regard to surface water quality. The effects of suspended solids in water are reflected in difficulties associated with water purification, decomposition in streams and injury to the habitat of fish.

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Water management in Ontario

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GUIDELINES and CRITERIA

for

WATER QUALITY MANAGEMENT

in

ONTARIO



GUIDELINES AND CRITERIA

FOR

WATER QUALITY MANAGEMENT IN ONTARIO

BY THE

ONTARIO WATER RESOURCES COMMISSION

HON. GEORGE A. KERR, Q.C.
Minister

R. D. JOHNSTON
Chairman

J. H. H. ROOT, M.P.P.
Vice-Chairman

135 St. Clair Avenue W., Toronto 7, Ontario
June, 1970

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INTRODUCTION

In 1967, the Ontario Water Resources Commission announced its Policy Guidelines for Water Quality Control in the Province of Ontario. This publication contains a re-statement of the guidelines and introduces water quality criteria for various uses including public, agricultural and industrial water supply, recreation, aesthetic enjoyment and the propagation of fish and wildlife. The use of water for assimilation and dilution of treated wastes must take into consideration these many desirable uses. Application of the criteria to water uses within the drainage basins of the province, or parts thereof, will lead to the development of water quality standards for the control of water pollution.

GUIDELINES FOR THE CONTROL OF WATER QUALITY

1 The water resources of Ontario must meet many needs, some of which are in conflict. The standards established, therefore, must be based on the best interests of the people of Ontario. These interests require the preservation, and restoration where necessary, of the quality of our water for the greatest number of uses. The use of water for the assimilation and dilution of treated waste effluents must take into consideration the variety of uses, including public, agricultural and industrial supply, recreation, aesthetic enjoyment and the propagation of fish and wildlife.

2 For each use of water there are certain water quality characteristics, identified as criteria, which should be met to ensure that the water is suitable for that use.

3 Water quality standards will be established by the Ontario Water Resources Commission for waters of drainage basins or parts thereof with important water uses, following consultation with agencies or persons having an interest or responsibility in the present or future use of the water in the basin for which the standards are to be established.

4 Water of a higher quality than that required by the standards will be maintained at that higher quality unless in the public interest an alteration of the quality is consistent with the protection of all uses which are in accordance with the water quality standards established.

There should be a constant effort to improve the quality of water, for it is recognized that the improvement of the quality of water makes it available for more uses.

5 Requirements for effluents and land drainage based on the applicable water quality standards, or criteria where such standards do not exist, will be established by the Commission in order to maintain acceptable water quality. More stringent methods of control and/or treatment of waste inputs and land drainage may become necessary as the use of water changes or increases, or as standards are re-defined.

6 In establishing effluent requirements from water quality standards a reserve capacity of the receiving water should be set aside to provide an adequate margin of protection in recognition of the limitations of water management theory and practice.

7 All wastes prior to discharge to any receiving watercourse must receive the best practicable treatment or control. Such treatment must be adequate to protect and wherever possible upgrade water quality in the face of population and industrial growth, urbanization and technological change.

8 Criteria and standards of water quality and effluent requirements will be defined quantitatively only where sound numerical information is available; otherwise, they will be described in appropriate detail. They will be re-defined from time to time in the light of new evidence.

WATER QUALITY CRITERIA

The following criteria for water quality are a set of numerical and descriptive characteristics, carefully defined, and applicable to each major water use category such as agriculture; fish, other aquatic life and wildlife; industrial water supply; public water supply; recreation and aesthetics. The criteria are described for use in establishing Water Quality Standards for drainage basins which in turn will be used to determine Effluent Requirements for discharges of wastes and land drainage.

The responsibility for demonstrating that a waste effluent is harmless to water uses in the concentrations to be found in the receiving waters, rests with those producing the discharge. Zones of passage and/or mixing adjacent to outfalls at the limit of which water quality may be critical, will be prescribed by the Commission.

Reference is frequently made in the Criteria to the Report of the Committee on Water Quality, Federal Water Pollution Control Administration, U.S. Department of the Interior (1968). Acknowledgement of the report is gratefully given in recognition of its basic reference value.

ZONES OF PASSAGE AND MIXING

Mixing zones in the vicinity of outfalls should be restricted as much as possible in extent and should provide for the safe passage of both fish and free-floating and drift organisms. Every precaution should be taken to ensure that at least two-thirds of the total cross-sectional area of a river or stream is characterized by a quality which is entirely favourable to the aquatic community at all times. In most cases this would preclude the use of a diffuser outfall which would distribute effluent uniformly across the river or stream. The water quality stand-

ard which defines the acceptable concentration of a substance contained in a waste discharge will apply at the periphery of the mixing zone or other specified sampling location.

Within mixing zones, it should be recognized that toxic wastes which will not evoke an avoidance response on the part of fish or other organisms should not be permitted. Where toxic materials are being discharged it should be assumed that the various components in the waste, regardless of the form in which they are present, may eventually be altered to the most toxic form in the aquatic environment. Adequate treatment of all wastes should be provided and mixing zones should not be considered as a substitute for proper treatment.

STATISTICAL PROBLEMS IN SETTING LIMITS

The systematic surveillance of water and waste sources requires the collection of data to clearly represent the problems being studied. The problems are many and varied. In one case the average condition over a period of time may be required and the question arises over what period shall the average or median be taken; in another, the limit may be a figure that should not be exceeded at any time. If a standard for a certain constituent is "none", the question arises "how small an amount does this mean?" The answers vary with the type of standard and the circumstances governing the fluctuation of the indicator. In ground water problems, only the average over a considerable period of time is significant. Where required in the setting of standards and effluent requirements, definitions of limits will include the applicable sampling conditions, quantitative values and rates of discharge.

1 WATER QUALITY CRITERIA FOR AGRICULTURAL USES (AGR)

Agricultural production requires water of suitable quality for a variety of uses. Criteria for the major uses are given under three headings: Dairy Sanitation, Livestock Watering, and Irrigation.

Requirements for domestic and other farmstead uses and the common requirements for dairy sanitation are given elsewhere in the criteria for Private Water Supplies and Public Water Supplies.

AGR-1 Dairy Sanitation

Modern methods for bulk handling of milk on farms require large volumes of good quality water to ensure a premium product. The quality of water needed for good dairy sanitation requires criteria for certain parameters that are additional to, or more stringent than, those required for private

water supplies. These are summarized under the headings "Permissible Criteria" and "Desirable Criteria". They should be used in conjunction with the criteria for public and private water supplies.

Treatment may prove satisfactory in meeting the criteria for certain of the inorganic chemicals such as iron and total hardness.

Waters that meet the desirable microbiological criteria can be used without disinfection; those meeting the permissible criteria require disinfection (chlorination), or chlorination and filtration, before use to reduce bacteria to levels where they will not cause deterioration of the quality of milk. Waters used for dairy sanitation should be sampled and tested at least monthly, in some cases daily, to ensure that they meet the microbiological criteria.

TABLE AGR-1
Water Quality Criteria for Agricultural Uses
Dairy Sanitation

Constituent or Characteristic	Permissible Criteria	Desirable Criteria
Inorganic Chemicals:		
Copper	0.1 mg/l	
Iron	0.1 mg/l	
pH (range)	6.8 to 8.5	
Potassium	20 mg/l	
Total hardness as CaCO ₃	150 mg/l	100 mg/l
Microbiological:		
Proteolytic and/or Lipolytic bacteria (20°C) (individual results)	500/100 ml	0/100 ml
Yeast		Absent
Mould		Absent
Physical:		Clear Colourless Good taste

AGR-2 Livestock Watering

The health and productivity of livestock are affected by the quantities of various substances ingested as feed and as water. Accordingly, the amounts of certain substances that can be present without harm in water consumed by livestock will depend in part on the amounts of the same substances that are present in the feed in addition to a number of other factors which include: the daily water requirements and the species, age, and physiological condition of the animals, and the nature and quantities of other constituents of the feed and water.

Animals may be able to tolerate a fairly high level of total dissolved solids or bacteria if they are accustomed to such levels, but may be unable to tolerate a sudden change from waters with low dissolved solids or bacteria to waters with high dissolved solids or bacteria.

In addition to direct effects on the animals, certain substances may contaminate animal products

to the point where they will not be acceptable for human consumption.

The variability of the factors that influence the acceptability of water for livestock-watering purposes must be considered when using the water quality criteria. Although the criteria provide a general guide to the quality of water that will be acceptable for most livestock, there may be cases where water of different quality than that indicated by the criteria will be required or acceptable because of the nature, age, or condition of species being raised or because of special rearing conditions or feed components. In such cases, or where the quality of an individual supply is in doubt, the quality should be assessed in relation to the specific use.

Water meeting the permissible criteria will be satisfactory for most livestock under normal rearing conditions. Water meeting the desirable criteria should provide a palatable and safe source for all normal livestock-watering purposes.

TABLE AGR-2
Water Quality Criteria for Agricultural Uses
Livestock

Constituent or Characteristic	Permissible Criteria	Desirable Criteria
General Quality		ideally should meet the desirable criteria for private water supplies.
Inorganic Chemicals:		
Total Dissolved Solids	2500 mg/l	< 500 mg/l
Arsenic	0.05 mg/l	Absent
Cadmium	0.01 mg/l	Absent
Chromium (hexavalent)	0.05 mg/l	Absent
Fluoride	2.4 mg/l	1.2 mg/l
Lead	0.05 mg/l	Absent
Nitrate plus Nitrite (as N)	20 mg/l	< 10 mg/l
Selenium	0.01 mg/l	Absent
Sulphate	1000 mg/l	< 250 mg/l
Radioactivity:		
Radium-226	3 pc/l	< 1 pc/l
Strontium-90	10 pc/l	< 2 pc/l
Gross beta activity in the known absence of strontium-90 and alpha-emitting radionuclides.	1000 pc/l	< 100 pc/l
Microbiological: (1)		
Enterococci (35°C)	< 40/100 ml	0/100 ml
Algae	No heavy growth of blue-green algae	

(1) The supply should be free of barnyard runoff and of effluent contamination from either man or animals. The geometric mean of sample results should not exceed the values given.

AGR-3 Irrigation

The suitability of water for irrigation cannot be defined precisely because the effects of the water on the crop being irrigated depend on many factors. These include: soil types, climatic conditions, irrigation practices, variations in the relation between the concentration and composition of the irrigation water and the soil solution, variations in the tolerance of different plants to the combined or individual constituents in the irrigation water or the soil solution, and the modifying effects of interrelations between and among the constituents. In general, for satisfactory irrigation, soils with poor drainage characteristics require water of higher quality than better drained soils.

In humid areas, excessive concentrations of salts or individual elements will normally be leached from the soil during periods of heavy rainfall or snowmelt before or after the growing season. This leaching action is another factor affecting the quality of water that can be used for irrigation. It may allow the use of water of poorer quality than that listed in these criteria for some crops and conditions without serious detrimental effects. Also through proper timing and adjustment of frequency and volumes of water applied, detrimental effects of poorer quality water may often be mitigated. Good drainage of soil may be a factor of similar importance as the quality of the water used.

The presence of sediment, pesticides, or pathogenic organisms in irrigation water, which may not specifically affect plant growth, may affect the acceptability of the product. Larger sediment particles could lead to plugging of sprinkler nozzles.

Although there are many variations in the quality of water that is suitable for specific irrigation uses, water quality criteria have been assembled as a guide to the quality of water that will meet many irrigation needs. The criteria are listed as permissible and desirable. Water meeting the desirable criteria should be satisfactory for irrigation of most crops in most soil types for long periods of time. Water meeting the permissible criteria, while suitable for many crops, soil and climatic conditions, could result in decreased yields for some crops if it is used repeatedly, unless there is dilution or leaching by precipitation or the application of excess irrigation water under favourable drainage conditions. Special crops or conditions, such as the growing of plants in greenhouses, may require irrigation with water of higher quality than that indicated by the desirable criteria.

The suitability of a given source of water for specific crops, soil types, and climatic conditions should be judged on an individual basis if its suitability has not been demonstrated by practice.

TABLE AGR-3
Water Quality Criteria for Agricultural Uses
Irrigation

Constituent or Characteristic	Permissible Criteria	Desirable Criteria
Physical:		
Temperature		55°F to 85°F
Microbiological: (1)		
Fecal Coliforms (44.5°C)	100/100 ml	0/100 ml
Enterococci (35°C)	20/100 ml	0/100 ml
Total bacteria (20°C)	100,000/100 ml	< 10,000/100 ml
Inorganic Chemicals:		
Aluminum	20.0 mg/l	< 1.0 mg/l
Arsenic	10.0 mg/l	< 1.0 mg/l
Beryllium	1.0 mg/l	< 0.5 mg/l
Boron	0.5 mg/l	0.3 mg/l
Cadmium	0.05 mg/l	< 0.005 mg/l
Chloride	150 mg/l	< 70 mg/l
Chloride—special requirement for tobacco	70 mg/l	< 20 mg/l
Chromium	20.0 mg/l	< 5.0 mg/l
Cobalt	10.0 mg/l	< 0.2 mg/l
Copper	5.0 mg/l	< 0.2 mg/l
Lead	20.0 mg/l	< 5.0 mg/l
Lithium	5.0 mg/l	< 5.0 mg/l
Manganese	20.0 mg/l	< 2.0 mg/l
Molybdenum	0.05 mg/l	< 0.005 mg/l
Nickel	2.0 mg/l	< 0.5 mg/l
pH (range)	4.8 to 9.0	
Residual Sodium Carbonate = $(\text{CO}_3^{--} + \text{HCO}_3^-) - (\text{Ca}^{++} + \text{Mg}^{++})$ expressed as mg eq/l	1.25 mg eq/l	< 1.25 mg eq/l
Selenium	0.05 mg/l	< 0.05 mg/l
Sodium Adsorption Ratio = $\frac{\text{Na}^+}{\sqrt{\frac{\text{Ca}^{++} + \text{Mg}^{++}}{2}}}$ expressed as mg eq/l	6	< 4
Total dissolved solids		
Vanadium	500 mg/l	< 200 mg/l
Zinc	10.0 mg/l	< 10.0 mg/l
	5.0 mg/l	< 5.0 mg/l
Organic Chemicals:		
Pesticides	Insecticides, herbicides, fungicides, and rodenticides must not be present in waters used for irrigation in concentrations that are detrimental to crops, livestock, wildlife or man.	Absent

(1) The geometric mean of sample results should not exceed the values given.

2 WATER QUALITY CRITERIA FOR THE PROTECTION OF FISH, OTHER AQUATIC LIFE AND WILDLIFE (F & W)

The following criteria are considered to be satisfactory for fish, other aquatic life and wildlife. Reference is made to aspects of water quality considered to be most important in the light of current knowledge. Narrative guidelines are offered where quantification is not yet possible.

Dissolved Materials

Dissolved materials should not be added to increase the concentration of dissolved solids by more than one-third of the natural condition of the receiving water, owing to potentially harmful osmotic effects of high concentrations. Dissolved materials that are harmful in relatively low concentrations are discussed in the section "Toxic Substances".

pH, Alkalinity, Acidity

(1) pH should be maintained within a range of 6.5 to 8.5.

(2) To protect the carbonate system, and thus the productivity of the water, acid should not be added in sufficient quantity to lower the total alkalinity to less than 20 mg/l.

Temperature

(1) General

Unless a special study shows that discharge of a heated effluent into the hypolimnion of a lake will be desirable, such practice is not recommended and water for cooling should not be pumped from the hypolimnion to be discharged to the same body of water.

The normal daily and seasonal temperature variations that were present before the addition of heat due to other than natural causes should be maintained.

Wherever possible, heated discharges should be located where elevated temperature will enhance public utilization of the water by supporting a wider variety of water uses.

(2) Great Lakes and Connecting Waters

(a) Heated discharges are not permitted that may stimulate production of nuisance organisms or vegetation or that are or may become injurious to wildlife, waterfowl, fish or other aquatic life or the growth and reproduction thereof. For each discharge of a heated effluent, acceptable mixing zones will be established on the basis of features and facts pertinent to that specific situation.

(b) Heat may not be discharged in the vicinity of spawning areas or where increased water tem-

perature might interfere with recognized movements of spawning or migrating fish populations.

(3) Inland Waters

(a) Heated discharges to inland waters will not be permitted unless it is clearly demonstrated that heated effluents will enhance the usefulness of the water resource without endangering the production and optimum maintenance of wildlife, fish and other aquatic species. It shall be the responsibility of the user to provide evidence to support the acceptability of the discharge under these terms.

(b) Inland trout streams, salmon streams, trout and salmon lakes and the hypolimnion of lakes and reservoirs containing salmonids and other cold water forms should not be warmed.

(c) Heat may not be discharged in the vicinity of spawning areas or where increased temperature might interfere with recognized movements of spawning or migrating fish populations.

Dissolved Oxygen

(1) Warm-water Biota

The dissolved oxygen (DO) concentration should be above 5 mg/l at all times, except that in certain situations concentrations may range between 5 and 4 mg/l for short intervals within any 24-hour period provided that water quality is favourable in all other respects.

(2) Cold-water Biota

In spawning areas, DO levels must not be below 7 mg/l at any time. Elsewhere, DO concentrations should not be below 6 mg/l. In certain situations, they may range between 6 and 5 mg/l for short intervals within any 24-hour period, provided the water quality is favourable in all other respects.

Carbon Dioxide

The 'free' carbon dioxide concentration should not exceed 25 mg/l.

Oil

Oil, petrochemicals or other immiscible substances that will cause visible films or toxic, noxious or nuisance conditions should not be added to water.

Turbidity

(1) Turbidity associated with waste inputs should not exceed 50 Jackson units in warm-water streams or 10 Jackson units in cold-water streams.

(2) There should be no discharge which would cause turbidities exceeding 25 Jackson units in warm-water lakes or 10 Jackson units in cold-water or oligotrophic lakes.

Settleable Materials

Substances should not be added that will adversely affect the aquatic biota or will create objectionable deposits on the bottom or shore of any body of water.

Colour and Transparency

For effective photosynthetic production of oxygen, it is required that 10 per cent of the incident light reach the bottom of any desired photosynthetic zone in which adequate dissolved oxygen concentrations are to be maintained.

Floating Materials

All floating materials, other than those of natural origin, should be excluded from streams and lakes.

Tainting substances

All materials that will impart odour or taste to fish or edible invertebrates should be excluded from receiving waters at levels that produce tainting.

Radionuclides

Radioactive materials should not be present in natural waters as a consequence of failure to exercise necessary controls of radioactivity releases to keep exposure to a minimum.

Experience has shown that standards established for drinking water assure that people will receive no more than currently acceptable amounts of radioactive materials from aquatic sources and that fish and other aquatic life will not receive an injurious dose of radiation.

Thus, present standards accepted for the protection of fish and other aquatic life are as follows:

	pc/l
Gross beta emitters	1000
Radium-226	3
Strontium-90	10

Where other radioisotopes occur, the significance of the exposure of aquatic species to these forms of radiation should be assessed for each situation, both with respect to potential damage to the organisms themselves and to humans where fish or other edible forms are utilized.

Plant Nutrients and Nuisance Growths

(1) Nutrients from unnatural sources that will stimulate production of algae, nuisance vegetation or offensive slime growths should not be added to water. The addition of sulphates or manganese oxide to a lake should be limited if iron is present in the hypolimnion as these substances may increase the quantity of available phosphorus.

(2) Organic or other materials that will promote an increased zone of anaerobic decomposition within a lake, reservoir or other body of water should not be allowed to enter the water.

(3) The naturally-occurring ratios of nitrogen (particularly NO_3 and NH_4) to total phosphorus, and their amounts, should not be radically changed by the addition of materials from waste sources and land drainage.

Toxic Substances

Toxic substances must not be added to water in concentrations or combinations that are toxic or harmful to human, animal, plant or aquatic life, except where the application of approved substances for the control of nuisance organisms has been authorized by the Commission (Section 28b, OWRC Act).

The evaluation of toxicity for aquatic organisms is based on use of the TLM or median tolerance limit. This represents the concentration at which half the test organisms will succumb over a given period of exposure such as 24, 48 or 96 hours. It does not, therefore, represent the safe concentration and an application factor is applied to ensure a safe condition, including allowance for sub-lethal effects.

(1) Substances of Unknown Toxicity

All effluents containing foreign materials should be considered harmful and not permissible until bioassay tests have shown otherwise. The onus for demonstrating that an effluent is harmless in the concentrations to be found in the receiving waters rests with those responsible for the discharge. Information concerning acceptable bioassay procedures is available from the Commission.

(2) Application Factors

Concentration of materials that are non-persistent (that is, have a half-life of less than 96 hours), or have non-cumulative effects after mixing with the receiving waters, should not exceed 1/10 of the applicable 96-hour TLM value at any time or place based on species representative of local conditions. The 24-hour average of the concentration of these materials should not exceed 1/20 of the TLM value after mixing. For other toxicants, the concentrations should not exceed 1/20 and 1/100 of the TLM value under the aforementioned conditions.

(3) Additive Effects

When two or more toxic materials that have additive effects are present at the same time in the receiving water, some reduction is necessary in the permissible concentrations as derived from bioassays on individual substances or wastes. The amount of reduction required is a function of both the number of toxic materials present and their concentrations in respect to the derived permissible concentration. An appropriate means of assuring that the combined

amounts of the several substances do not exceed a permissible concentration for the mixture is through the use of the following relationship:

$$\left(\frac{C_a}{L_a} + \frac{C_b}{L_b} + \dots + \frac{C_n}{L_n} \leq 1 \right)$$

where $C_a, C_b, \dots, C_n$ are the measured concentrations of the several toxic materials in the water and $L_a, L_b, \dots, L_n$ are the respective permissible concentration limits derived for the materials on an individual basis. Should the sum of the several fractions exceed one, then a local restriction on the concentration of one or more of the substances is necessary.

(4) Pesticides

(a) Chlorinated Hydrocarbons:

Any addition of chlorinated hydrocarbon insecticides is likely to cause damage to some desired organisms and their use should be avoided.

(b) Other Chemical Pesticides:

Other pesticides and herbicides gaining access to water can cause damage to desirable organisms and should be used with utmost discretion and caution. Tables F & W-1 and F & W-2 list the 48-hour TLM values of a number of pesticides for various types of fresh water organisms. To provide reasonably safe concentrations of these materials in receiving waters, application factors ranging from 1/10 to 1/100 should be used, with these values depending on the characteristic of the pesticide in question and used as specified in (2) above. Concentrations thus derived may be considered tentatively safe under the conditions specified. TLM values and related application factors are subject to revision as additional bioassay information is obtained for species which may be more representative of local conditions.

(5) Other Toxic Substances

- (a) ABS: The concentration of ABS should not exceed 1/7 of the 48-hour TLM at any time or place.
- (b) LAS: The concentration of LAS should not exceed 1/7 of the 48-hour TLM at any time or place.
- (c) ARSENIC: An application factor of 1/100 should be applied to the 96-hour TLM value as a tentative safe concentration for continuous exposure. An environmen-

tal level of .01 mg/l should not be exceeded under any circumstances.

- (d) AMMONIA: Permissible concentrations of ammonia should be determined by the flow-through bioassay with the pH of the test solution maintained at 8.5, DO concentrations between 4 and 5 mg/l, and temperatures near the upper allowable levels.
- (e) CADMIUM: The concentration of cadmium must not exceed 1/500 of the 96-hour TLM concentration at any time or place.
- (f) CHROMIUM: The concentration of chromium should not exceed 1/100 of the 96-hour TLM at any time or place.
- (g) COPPER: The maximum copper (expressed as Cu) concentration at any time or place shall not be greater than 1/12 of the 96-hour TLM value. The maximum permissible concentration for continuous exposure is between 3 per cent and 7 per cent of the 96-hour TLM.
- (h) LEAD: The concentration of lead should not exceed 1/20 of the 96-hour TLM at any time or place and the 24-hour average should not exceed 1/100 of the 96-hour TLM concentration after mixing.
- (i) MERCURY: Owing to demonstrated cumulative effects of mercury in fish, and the attendant hazard to other animals, discharges of mercury to water should be avoided.
- (j) NICKEL: The concentration of nickel should not exceed 1/50 of the 96-hour TLM concentration at any time or place.
- (k) ZINC: The concentration of zinc should not exceed 1/100 of the 96-hour TLM concentration at any time or place.

TABLE F & W-1 INSECTICIDES*

(48-hour TLM values from static bioassay, in micrograms per litre. Exceptions are noted.)

Pesticide	Stream Invertebrate ¹		Cladocerans ²		Fish ³		Gammarus Lacustris, ⁴ TLM
	Species	TLM	Species	TLM	Species	TLM	
Abate	Pteronarcys californica	100			Brook trout	1,500	640
Aldrin ⁵	P. californica	8	Daphnia pulex	28	Rainbow trout	3	12,000
Allethrin	P. californica	28	D. pulex	21	- do -	19	20
Azodrin					- do -	7,000	
Aramite			D. magna	345	Bluegill	35	100
Baygon ⁵	P. californica	110			Fathead	25	50
Baytex ²	P. californica	130	Simocephalus serrulatus	3.1	Brown t.	80	70
Benzene hexachloride (lindane)	P. californica	8	D. pulex	460	Rainbow t.	18	88
Bidrin	P. californica	1900	D. pulex	600	- do -	8,000	790
Carbaryl (sevin)	P. californica	1.3	D. pulex	6.4	Brown t.	1,500	22
Carbophenothion (trithion)			D. magna	0.009	Bluegill	225	28
Chlordane ⁵	P. californica	55	S. serrulatus	20	Rainbow t.	10	80
Chlorobenzilate			S. serrulatus	550	- do -	710	
Chlorthion			D. magna	4.5			
Coumaphos			D. magna	1			0.14
Cryolite			D. pulex	5,000	Rainbow t.	47,000	
Cyfluthrin			D. magna	55			
DDD (TDE) ⁵	P. californica	1100	D. pulex	3.2	Rainbow t.	9	1.8
DDT ⁵	P. californica	19	D. pulex	0.36	Bass	2.1	2.1
Delnav (dioxathion)					Bluegill	14	690
Delmeton (systex)				14	- do -	81	
Diazinon ⁵	P. californica	60	D. pulex	0.9	- do -	30	500
Dibrom (naled)	P. californica	16	D. pulex	3.5	Brook t.	78	160
Dieldrin ⁵	P. californica	1.3	D. pulex	240	Bluegill	3.4	1,000
Dilan			D. magna	21	- do -	16	600
Dimethoate (cygon)	P. californica	140	D. magna	2500	- do -	9600	400
Dimethrin					Rainbow t.	700	
Dichlorvos ⁵ (DDVP)	P. californica	10	D. pulex	0.07	Bluegill	700	1
Disulfoton (di-syston)	P. californica	18			- do -	40	70

* From Report of the Committee on Water Quality Criteria, Federal Water Pollution Control Administration, U.S. Department of the Interior (1968).

TABLE F & W-1—continued

Pesticide	Stream Invertebrate ¹		Cladocerans ²		Fish ³		Gammarus Lacustris, ⁴ TLm
	Species	TLm	Species	TLm	Species	TLm	
Dursban	Peteronareella badia	1.8			Rainbow t.	20	0.4
Endosulfan (thiodan)	P. californica	5.6	D. magna	240	- do -	1.2	64
Endrin ⁵	P. californica	0.8	D. pulex	20	Bluegill	0.2	4.7
EPH			D. magna	0.1	- do -	17	36
Ethion	P. californica	14	D. magna	0.01	- do -	230	3.2
Ethyl guthion ⁵			D. pulex		Rainbow t.		
Fenthion	P. californica	39	D. pulex	4			
Guthion ⁵	P. californica	8	D. magna	0.2	Rainbow t.	10	0.3
Heptachlor ⁵	P. badia	4	D. pulex	42	- do -	9	100
Kelthane (dicofel)	P. californica	3000	D. magna	390	- do -	100	
Kepone					- do -	37.5	
Malathion ⁵	P. badia	6	D. pulex	1.8	Brook t.	19.5	1.8
Methoxychlor ⁵	P. californica	8	D. pulex	0.8	Rainbow t.	7.2	1.3
Methyl parathion ⁵			D. magna	4.8	Bluegill	8000	
Morestan	P. californica	40			- do -	96	
Ovex	P. californica	1500			- do -	700	
Paradichlorobenzene					Rainbow t.	880	
Parathion ⁵	P. californica	11	D. pulex	0.4	Bluegill	47	6
Perthane			D. magna	9.4	Rainbow t.	7	
Phosdrin ⁵	P. californica	9	D. pulex	0.16	- do -	17	310
Phosphamidon	P. californica	460	D. magna	4	- do -	8000	3.8
Pyrethrins	P. californica	64	D. pulex	25	- do -	54	18
Rotenone	P. californica	900	D. pulex	10	Bluegill	22	350
Strobane ⁵	P. californica	7			Rainbow t.	2.5	
Tetradifon (tedion)					Bluegill	1100	140
TEPP ⁵					Fathead	390	52
Thanite			D. magna	450			
Thimet					Bluegill	5.5	70
Toxaphene ⁵	P. californica	7	D. pulex	15	Rainbow t.	2.8	70
Trichlorofon (dipterex) ⁵	P. badia	22	D. magna	8.1	- do -	160	60
Zectran	P. californica	16	D. pulex	10	- do -	8000	76

TABLE F & W-2

HERBICIDES, FUNGICIDES, DEFOLIANTS, ALGICIDES*

Pesticide	Stream Invertebrate ¹		Cladocerans ²		Fish ³		Gammarus Lacustris, ⁴ TLm
	Species	TLm	Species	TLm	Species	TLm	
Ametryne					Rainbow t.	3400	
Aminotriazole							
Aquathol					Bluegill	257	
Atrazine			Daphnia magna	3600	Rainbow t.	12,600	
Azide, potassium					Bluegill	1400	10,000
Azide, sodium					- do -	980	9000
Copper chloride					- do -	1100	
Copper sulphate					- do -	150	
Dichlobenil	Pteronarcys californica	44,000	Daphnia pulex	3700	- do -	20,000	1500
2,4-D PGBEE			D. pulex	3200	Rainbow t.	960	1800
2,4-D BEE	P. californica	1800			Bluegill	2100	760
2,4-D isopropyl					- do -	800	
2,4-D butyl ester					- do -	1300	
2,4-D butyl + isopropyl ester					- do -	1500	
2,4,5-T isooctyl ester					- do -	16,700	
2,4,5-T isopropyl ester					- do -	1700	
2,4,5-T PGBE					- do -	560	
2(2,4-DP) BEE					- do -	1100	
Dalapon	P. californica		D. magna	6000			
	Very low toxicity						Very Low Toxicity
Dead-X	P. californica	5000	D. pulex	3700	Rainbow t.	9400	5600
DEF	P. californica	2300			Bluegill	36	230
Dexon	P. californica	42,000			Bluegill	23,000	6000
Dicamba					non-toxic		5800
Dichlone			D. magna	26	Rainbow t.	48	11,500
Difolitan	P. californica	150			Channel Cat	31	6500
Dinitroresol	P. californica	560			Rainbow t.	210	
Diquat					Rainbow t.	12,300	
Diuron	P. californica	2800	D. pulex	1400	- do -	4300	380
Du-ter					Bluegill	33	
Dyrene			D. magna	490		15	
Endothal, copper					Rainbow t.	290	

* From Report of the Committee on Water Quality Criteria, Federal Water Pollution Control Administration, U.S. Department of the Interior (1968).

TABLE F & W-2—continued

Pesticide	Stream Invertebrate ¹		Cladocerans ²		Fish ³		Gammarus Lacustris, ⁴ TLm
	Species	TLm	Species	TLm	Species	TLm	
Endothal dimethylamine					Rainbow t.	1150	
Fenac, acid	P. californica	70,000			- do -	16,500	
Fenac, sodium	P. californica	80,000	D. pulex	4500	- do -	7500	18,000
Hydram (molineate)	P. californica	3500			- do -	290	
Hydrothol 191					- do -	690	1000
Lanstan (Korax)					- do -	100	5500
LFN					- do -	79	
Paraquat	P. californica		D. pulex	3700	Very low toxicity		18,000
	Very low toxicity				Rainbow t.	7800	
Propazine					- do -	650	
Silvex, PGBEE			D. pulex	2000	Bluegill	1400	
Silvex, isocetyl					- do -	1200	
Silvex, BEE					Rainbow t.	5000	21,000
Simazine	P. californica	50,000	Simocephalus	1400	- do -	36,500	
Sodium arsenite	P. californica		serrulatus				
	Very low toxicity				- do -	2500	48,000
Tordon (picloram)					- do -	11	5600
Trifluralin	P. californica	4200	D. pulex	240	- do -	5900	25,000
Vernam ⁵ (vernolate)							

1 Stonefly bioassay was done at Denver, Colo., and at Salt Lake City, Utah. Denver tests were in soft water (35 mg/l TDS), non-aerated, 60 F. Salt Lake City tests were in hard water (150 mg/l TDS), aerated, 48-50 F. Response was death.

2 Daphnia pulex and Simocephalus serrulatus bioassay was done at Denver, Colo., in soft water (35 mg/l TDS), non-aerated, 60 F. Daphnia magna bioassay was done at Pennsylvania State University in hard water (146 mg/l TDS), non-aerated, 68 F. Response was immobilization.

3 Fish bioassay was done at Denver, Colo., and at Rome N.Y. Denver tests were with 2-inch fish in soft water (35 mg/l TDS), non-aerated, trout at 55 F.; other species at 65 F. Rome tests were with 2-2 1/2 inch fish in soft water (6 mg/l TA: pH 5.85-6.4), 60 F. Response was death.

4 Gammarus bioassay was done at Denver, Colo., in soft water (35 mg/l TDS), non-aerated, 60 F. Response was death.

5 Becomes bound to soil when used according to directions, but highly toxic (reflected in numbers) when added directly to water.

3 WATER QUALITY CRITERIA FOR INDUSTRIAL WATER SUPPLIES (IWS)

Desired water quality criteria are tabled for the major industrial classifications as follows:

Brewing and Soft Drinks	— IWS-1
Chemical and Allied Products	— IWS-2
Industrial Cooling	— IWS-3
Food Processing	— IWS-4
Electroplating and Metal Finishing	— IWS-5
Iron and Steel	— IWS-6
Petroleum	— IWS-7
Pulp and Paper	— IWS-8
Leather Tanning and Finishing	— IWS-9
Textiles	— IWS-10

While the values listed should not normally be exceeded, these water quality criteria can vary considerably for the same industrial process depending on factors such as the technological age of plant design.

A raw surface water and/or ground water supply which is used by many different industries may not satisfy the widely varying criteria for each use. However, water treatment technology in its present state of development permits the utilization of surface water of literally any available quality to produce water of any desired quality at the point of use in industry.

Most industries located on municipal water supply systems find the quality of water provided to be satisfactory. If the water quality requirements of an industry are such that water of higher quality than that provided by the municipality is required for specific process use, the industry generally accepts the additional costs involved to produce the higher quality water.

TABLE IWS-1

WATER QUALITY CRITERIA FOR THE BREWING AND SOFT DRINK INDUSTRIES

(Unless otherwise indicated, units are mg/l)

Characteristic	Concentration
Alkalinity (CaCO ₃)	85
pH, units	(1)
Hardness (CaCO ₃)	(1)
Chloride (Cl)	250 ⁽²⁾
Sulphate (SO ₄)	250 ⁽²⁾
Iron (Fe)	0.3 ⁽³⁾
Manganese (Mn)	0.05
Fluoride (F)	1 ⁽³⁾
Dissolved solids	(1)
Organics: carbon chloroform extract (CCE)	0.15 ⁽³⁾
Coliform bacteria, count/100 ml	(3)
Colour, units	5 ⁽⁴⁾

Taste, threshold number
Odour, threshold number

(4, 5)

(4, 5)

- (1) Controlled by treatment for other constituents.
- (2) For brewing, value should not exceed 100 mg/l.
- (3) Not greater than OWRC Drinking Water Objectives.
- (4) In general, public water supplies are given conventional treatment such as coagulation, filtration and chlorination. Any additional requirement for higher quality, for example, deionized water, is the responsibility of the industry. To ensure low organic content, activated carbon treatment is used by industry.
- (5) Zero, not detectable by test.

TABLE IWS-2

WATER QUALITY CRITERIA FOR THE CHEMICAL AND ALLIED PRODUCTS INDUSTRIES*

(Unless otherwise indicated, units are mg/l)

Characteristic	Concentration ¹
Alkalinity (as CaCO ₃)	150
Iron (Fe)	0.3
Manganese (Mn)	0.1
Calcium (Ca)	50
Magnesium (Mg)	25
Bicarbonate (HCO ₃)	250
Sulphate (SO ₄)	250
Chloride (Cl)	250
Nitrate (NO ₃) as N	10
Hardness (as CaCO ₃)	250
pH, units	6.5-8.5
Dissolved solids	750
Silica	50
Colour, units	20
Suspended solids	15

* Industries include the manufacture of synthetic rubber, plastics, fertilizers, soap and detergents, organic and inorganic chemicals, etc.

- (1) Because of the varying requirements of the many uses in the vast number of chemical industries, more stringent restrictions are placed on several of the above noted characteristics. In some cases, any concentration can be handled, while in others, the raw water is accepted as received provided it meets total solids or other limiting values. The above concentrations are suggested guidelines that should be suitable for the majority of uses in the chemical industry.

TABLE IWS-3

WATER QUALITY CRITERIA FOR COOLING WATER*

(Unless otherwise indicated, units are mg/l)

Characteristic	Concentration
Turbidity	50
Hardness	50
Iron	0.5
Manganese	0.5

- * Cooling waters should have appropriate initial temperatures and should not deposit scale, be corrosive or encourage the growth of slimes. Among the constituents of natural water that may prove detrimental to its use for cooling purposes are hardness, suspended solids, dissolved gases, acids, oil and other organic compounds and slime-forming organisms.

TABLE IWS-4

WATER QUALITY CRITERIA FOR THE FOOD PROCESSING INDUSTRY

(Unless otherwise indicated, units are mg/l)

Characteristic	Concentration
Alkalinity (CaCO ₃)	150
pH, units	6.5-8.5
Hardness (CaCO ₃)	150
Chloride (Cl)	250
Sulphate (SO ₄)	250
Iron (Fe)	0.2
Manganese (Mn)	0.2
Chlorine (Cl)	(1)
Fluoride (F)	1 ⁽²⁾
Silica (SiO ₂)	50
Phenol	(3, 4)
Nitrate (NO ₃) as N	10 ⁽²⁾
Nitrite (NO ₂) as N	(3)
Organics:	
Carbon chloroform extract (CCE)	0.15
Odour, threshold number	(3)
Taste, threshold number	(3)
Turbidity	(6)
Colour, units	5
Dissolved solids	500
Suspended solids	10
Coliform, count/100 ml	(6)
Total bacteria, count/100 ml	(7)

- (1) Process waters for food canning are purposely chlorinated to a selected, uniform level. An unchlorinated supply must be available for preparation of canning syrups.
- (2) Waters used in the processing and formulation of foods for babies should be low in fluorides concentration. Also, because high nitrate intake is alleged to be involved in infant illnesses, the concentration of nitrates in waters used for processing baby foods should be low.
- (3) Zero, not detectable by test.
- (4) Because chlorination of food processing waters is a desirable and widespread practice, the phenol content of intake waters must be considered. Phenol and chlorine in water can react to form chlorophenol, which even in trace amounts can impart a medicinal off-flavour to foods.
- (5) Maximum permissible concentration may be lower depending on type of substance and its effect on odour and taste.
- (6) As required by OWRC Drinking Water Objectives.
- (7) The total bacterial count must be considered as a quality requirement for waters used in certain food processing operations. Other than aesthetic considerations, high bacterial concentration in waters coming in contact with frozen foods may significantly increase the count per gram for the food. Waters used to cool heat-sterilized

cans or jars of food must be low in total count for bacteria to prevent serious spoilage due to aspiration of organisms through container seams. Chlorination is widely practised to assure low bacterial counts on container cooling waters.

WATER QUALITY CRITERIA FOR THE ELECTRO- PLATING AND METAL FINISHING INDUSTRIES — IWS-5

Plating-room processes that utilize water include the stripping or pickling operations, cleaning by organic solvents or alkaline solutions, rinsing, and electrochemical plating. For acid stripping or for alkaline cleaning, the quality of water used in the baths is seldom critical, for the added chemicals far outweigh the natural constituents of the water. Hardness of water may be detrimental when soaps or alkaline cleaning agents are used.

For rinsing and for plating, water quality is frequently a major problem. High quality water is of primary importance to assure satisfactory finished work. For decorative plating, water spots and stains may necessitate reworking, wiping, buffing, and other laborious operations. Before the application of any organic corrosion-resistant coating, it is almost a necessity to use demineralized water in the final rinse, in order to achieve adhesion of the coating. A high concentration of dissolved solids is especially detrimental in rinse waters.

In plating baths, iron, aluminum, calcium, magnesium, sodium, potassium, carbonate, bicarbonate, sulphide, sulphite, sulphate, fluoride, chloride, silicate, copper, and lead have been reported to cause difficulties under certain conditions. Considerable evaporation occurs from plating baths and hence the ions present in the make-up water are concentrated to the extent that they are troublesome.

Calcium and magnesium are especially troublesome in plating baths, for they tend to precipitate to form scale on the heated surface or a sludge in the water. There is a probability of these precipitates being included in the electro-deposit, causing pits, porosity, and roughness. Magnesium may also reduce the "throwing power" in chromium baths, but on the other hand, magnesium sulphate is sometimes added to nickel-plating baths to produce softer deposits, to minimize certain types of pitting, and to increase throwing power.

Sodium and potassium are generally not harmful in plating operations, although sodium may cause brittle deposits in nickel baths or reduce the throwing power in chromium solutions. Iron is one of the most troublesome pollutants of many plating operations. In a nickel-sulphate bath, it may cause hazy, streaked, pitted, or brittle deposits; in acid copper solutions, it produces rough deposits; in chromium baths, it reduces the throwing power; in

cadmium cyanide, it causes hazy deposits; in silver cyanide, stained deposits; and in zinc sulphate baths it lowers the plating efficiency and the protective value of the coating.

Among the anions, bicarbonates are detrimental in heated alkaline baths, for they tend to be converted to carbonates and accelerate the precipitation of calcium. Moreover, they buffer the water and require higher dosages of acid or alkali to obtain

the desired pH value. Chlorides have been reported to cause rough, modular, iridescent, and crystalline deposits in cadmium, copper, silver, and tin baths respectively. Organic substances reduce chromium, and cause rough, hazy, streaked, coloured, or pitted deposits under various conditions. Colour and turbidity are similarly objectionable.

Abstracted from "Water Quality Criteria", 2nd Edition, State Water Quality Control Board, California, Publication No. 3-A.

TABLE IWS-6
WATER QUALITY CRITERIA FOR THE
IRON AND STEEL INDUSTRY
(Unless otherwise indicated, units are mg/l)

Characteristic	Quenching, hot rolling, gas cleaning	Cold rolling	Selected rinse waters	
			Softened	Demineralized
Suspended solids	25	10	(2)	(2)
Dissolved solids	(1)	(1)	(1)	(2)
Alkalinity (CaCO ₃)	(3)	(3)	(3)	(2)
Hardness (CaCO ₃)	(3)	(3)	100	(2)
pH, units	6.0-9.0	6.0-9.0	6.0-9.0	(3)
Chloride (Cl)	150	150	150	(2)
Dissolved oxygen (O ₂)	(4)	(4)	(4)	(4)
Temperature, °F	100	100	100	100
Oil	(1)	(2)	(2)	(2)
Floating material	(1)	(2)	(2)	(2)

(1) Accepted as received if meeting total solids or other limiting values.

(2) Zero, not detectable by test.

(3) Controlled by treatment for other constituents.

(4) Minimum to maintain aerobic conditions.

TABLE IWS-7
WATER QUALITY CRITERIA FOR THE
PETROLEUM INDUSTRY
(Unless otherwise indicated, units are mg/l)

Characteristic	Concentration
Silica (SiO ₂)	(1)
Iron (Fe)	1
Calcium (Ca)	75
Magnesium (Mg)	25
Bicarbonate (HCO ₃)	(1)
Sulphate (SO ₄)	(1)
Chloride (Cl)	200
Fluoride (F)	(1)
Nitrate (NO ₃) as N	(1)
Dissolved solids	750
Suspended solids	10
Hardness (CaCO ₃)	350
Noncarbonate hardness (CaCO ₃)	70
Colour, units	(1)
pH, units	6.0-9.0

(1) Accepted as received if meeting total solids or other limiting values.

TABLE IWS-8
WATER QUALITY CRITERIA FOR THE
PULP AND PAPER INDUSTRY
(Unless otherwise indicated, units are mg/l)

Characteristic	Mechanical Pulping	Chemical Pulp and Paper	
		Unbleached	Bleached
Silica (SiO ₂)	(1)	50	50
Aluminum (Al)	(1)	(1)	(1)
Iron (Fe)	0.3	1.0	0.1
Manganese (Mn)	0.1	0.1	0.05
Zinc (Zn)	(1)	(1)	(1)
Calcium (Ca)	(1)	20	20
Magnesium (Mg)	(1)	10	10
Sulphate (SO ₄)	(1)	(1)	(1)
Chloride (Cl)	500	200	200
Dissolved solids	(1)	(1)	(1)
Suspended solids	(1)	10 ⁽²⁾	10 ⁽²⁾
Hardness (CaCO ₃)	(1)	100	100
pH, units	6.0-9.0	6.0-9.0	6.0-9.0
Colour, units	30	30	10
Temperature, °F	(1)	(1)	95

(1) Accepted as received if meeting total solids or other limiting values.

(2) No gritty or colour-producing solids.

TABLE IWS-9

**WATER QUALITY CRITERIA FOR THE
LEATHER TANNING AND FINISHING INDUSTRY**

(Unless otherwise indicated, units are mg/l)

Characteristic	Tanning Processes	General Finishing Processes	Colouring
Alkalinity (CaCO ₃)	(1)	130	130
pH, units	6.0-8.0	6.0-8.0	6.0-8.0
Hardness (CaCO ₃)	150	(2)	(3, 4)
Calcium (Ca)	60	(2)	(3, 4)
Chloride (Cl)	250	250	(5)
Sulphate (SO ₄)	250	250	(5)
Iron (Fe)	0.3	0.3	0.1
Manganese (Mn)	0.2	0.2	0.01
Organics:			
Carbon chloroform extract (CCE)	(5)	0.2	(3)
Colour, units	5	5	5
Coliform bacteria, count/100 ml	(6)	(6)	(5)
Turbidity	(3)	(3)	(3)

(1) Accepted as received if meeting total solids or other limiting values.

(2) Lime softened.

(3) Zero, not detectable by test.

(4) Demineralized or distilled water.

(5) Concentration not known.

(6) OWRC Drinking Water Objectives.

TABLE IWS-10

**WATER QUALITY CRITERIA FOR THE
TEXTILE INDUSTRY**

(Unless otherwise indicated, units are mg/l)

Characteristic	Sizing Suspension	Scouring	Bleaching	Dyeing
Iron (Fe)	0.3	0.1	0.1	0.1
Manganese (Mn)	0.05	0.01	0.01	0.01
Copper (Cu)	0.05	0.01	0.01	0.01
Dissolved solids	100	100	100	100
Suspended solids	5	5	5	5
Hardness (CaCO ₃)	25	25	25	25
pH, units:				
Cotton	6.5-10.0	9.0-10.5	2.5-10.5	7.5-10.0
Synthetics	6.5-10.0	3.0-10.5	(1)	6.5-7.5
Wool	6.5-10.0	3.0-5.0	2.5-5.0	3.5-6.0
Colour, units	5	5	5	5

(1) Not applicable.

4 CRITERIA FOR PUBLIC WATER SUPPLIES (PWS)

Criteria are given for public and private supplies from both surface and ground water sources.

Public supplies include water systems operated by municipalities, public utilities, industries, commissions, commercial establishments, etc. where competent operation of the water supply system is provided.

Private supplies include water systems operated by personnel who may not have the necessary technical or mechanical expertise.

PWS-1 Criteria for Public Surface Water Supplies

Since treatment processes exist which can convert any raw water (with a few minor exceptions) to potable water, it is necessary to define a commonly accepted treatment system which can produce a potable water at a reasonable cost. For the purposes of these criteria, such a system has been

defined to consist of coagulation, flocculation, sedimentation and rapid sand filtration; the use of chemicals is restricted by definition to the commonly used coagulants and chlorine for disinfection.

Two types of criteria have been established, namely the Permissible Criteria and the Desirable Criteria (Table PWS-1). Waters meeting both of these criteria are acceptable for treatment by the defined treatment process stated above. Waters meeting the Desirable Criteria provide for a greater margin of safety.

It should be borne in mind that the values given under the Permissible Criteria cannot be considered as maximum single sample values. These criteria should not be exceeded over substantial portions of time. If this should occur, then it will become necessary to determine the cause and initiate corrective action. The frequency and variety of sampling should be based on the findings of a comprehensive pollution survey.

TABLE PWS-1
WATER QUALITY CRITERIA FOR
PUBLIC SURFACE WATER SUPPLIES
 (Unless otherwise indicated, units are mg/l)

Constituent or Characteristic	Permissible Criteria	Desirable Criteria
Physical		
Colour (platinum-cobalt)	75 units	< 5 units
Odour	Readily removable by defined treatment	Absent
Turbidity	— do —	Absent
Temperature	85°F	Pleasant tasting
Inorganic Chemicals		
Ammonia	0.5 (as N)	< 0.01
Arsenic*	0.05	Absent
Barium*	1.0	Absent
Boron*	1.0	Absent
Cadmium*	0.01	Absent
Chloride*	250	< 25
Chromium* (hexavalent)	0.05	Absent
Copper*	1.0	Virtually absent
Dissolved Oxygen	≥ 4 (monthly mean) ≥ 3 (individual sample)	Near saturation
Fluoride*	See footnote (1)	1.0
Hardness*	Acceptable levels will vary with local hydrogeologic conditions and consumer acceptance.	
Iron (filterable)	0.3	Virtually absent
Lead*	0.05	Absent
Manganese* (filterable)	0.05	Absent
Nitrate plus Nitrite*	10 (as N)	Virtually absent
pH range	6.0 - 8.5 units	Least amount of interference with treatment process
Phosphorus* (phosphates)	Not encourage growth of algae or interfere with treatment process	
Selenium*	0.01	Absent
Silver*	0.05	Absent
Sulphate*	250	< 50
Total Dissolved Solids* (filterable residue)	500	< 200
Uranyl Ion*	5	Absent
Zinc*	5	Virtually absent
Organic Chemicals⁽²⁾		
Carbon chloroform extract* (CCE)	0.15	< 0.04
Cyanide*	0.20	Absent
Methylene blue active substances*	0.5	Virtually absent
Oil and grease*	Virtually absent	Absent

Table PWS-1 (cont.)

Constituent or Characteristic	Permissible Criteria	Desirable Criteria
Pesticides:		
Aldrin*	0.017	— do —
Chlordane*	0.003	— do —
DDT*	0.042	— do —
Dieldrin*	0.017	— do —
Endrin*	0.001	— do —
Heptachlor*	0.018	— do —
Heptachlor epoxide*	0.018	— do —
Lindane*	0.056	— do —
Methoxychlor*	0.035	— do —
Organic phosphates plus carbamates*	0.1	— do —
Toxaphene*	0.005	— do —
Herbicides:		
2,4-D plus 2,4,5-T, plus 2,4,5-TP*	0.1	— do —
Phenolic Substances*	Virtually absent	— do —
Radioactivity		
	(pc/l)	(pc/l)
Gross beta*	1,000	< 100
Radium-226*	3	< 1
Strontium-90*	10	< 2
Microbiological ⁽³⁾		
Coliform organisms (at 35°C)	5,000/100 ml	< 100/100 ml
Fecal coliforms (44.5°C)	500/100 ml	< 10/100 ml
Fecal streptococci (35°C)	50/100 ml	< 1/100 ml
Total Bacteria (20°C)	100,000/100 ml	< 1,000/100 ml
Clostridia (in water) (35°C)	50/100 ml	0/100 ml

* The defined treatment process has little effect on the constituents.

- | | |
|--|--|
| <p>(1) Annual Avg. of Max. Daily Air Temp. F.
 50.0 to 53.7
 53.8 to 58.3
 58.4 to 63.8</p> | <p>Recommended Limit for Fluoride mg/l
 1.7
 1.5
 1.3</p> |
|--|--|
- (2) Organic chemicals should not be present in concentrations as to cause adverse tastes and odours which cannot be removed by the defined treatment and/or by chlorination only.
- (3) A monthly geometric mean of the results of raw water samples collected on a weekly basis (minimum of one sample per week) should be less than the numbers given under the Permissible Criteria column. These figures do not imply a relationship between bacterial groups.

PWS-2 Criteria for Public Ground Water Supplies

With the exception of dissolved oxygen, fluorides and microbiological criteria, the water quality criteria for surface water apply to ground water supplies.

For fluorides, hydrogen sulphide and pollution indicator organisms, the following apply to ground water supplies:

	<u>Permissible Criteria</u>	<u>Desirable Criteria</u>
	(Unless otherwise indicated, units are mg/l)	
Fluoride	2.4	1.0
Hydrogen Sulphide	0.1	Absent
Pollution Indicator Organisms	Coliform and other pollution indicator organisms should be virtually absent from all ground water supplies.	

It is considered desirable to provide the maximum of treatment — chlorination — for all ground water supplies. This measure ensures that nuisance organisms which exist in virtually all waters do not get the opportunity to develop a foothold in a water distribution system and thereby create objectionable conditions.

PWS-3 Criteria for Private Water Supplies

The raw water available to private supplies such as individual dwellings, cottages, farms, etc., must be of such quality that it can be used in the raw state or be made acceptable for use with a minimum of treatment limited to disinfection, filtration and/or softening. Economic considerations and

lack of technical/mechanical expertise will prohibit the use of raw water supplies that require extensive treatment.

Some surface supplies have turbidities, colour and other undesirable constituents in excess of what can be used effectively in home or farm operations. Some ground water supplies (wells and springs) harbour objectionable gases, nuisance bacteria, in addition to having high concentrations of iron and being highly mineralized. The initial approach in establishing a private water supply should be to explore the ground water potential from the aspects of both quality and quantity. In many instances, deficiencies in ground water quality can be offset at a relatively low cost compared to that for surface waters.

Criteria for private water supplies are identical to the surface water criteria for public water supplies, with the exception of fluorides, hydrogen sulphide, physical and microbiological characteristics. For fluorides and hydrogen sulphide, the applicable criteria appear in Section PWS-2.

Physical Criteria:

The water supply should be substantially free from substances offensive to sight, taste or smell. Threshold odour values in excess of three units are generally considered objectionable.

Colour in the water supply should not exceed 15 units (platinum-cobalt scale).

Turbidity should be less than five units. Turbidities of up to 20 units may be removed relatively easily by sand or diatomaceous earth filters.

Microbiological Criteria:

Microorganisms	<u>Permissible Criteria</u>		<u>Desirable Criteria</u>
	<u>Chlorination only</u>	<u>Chlorination & Filtration</u>	<u>No Treatment</u>
Coliforms (35°C)	100/100 ml	400/100 ml	0/100 ml
Fecal Coliforms (44.5°C)	10/100 ml	40/100 ml	0/100 ml
Enterococci (35°C)	1/100 ml	4/100 ml	0/100 ml
Total Bacteria (20°C)	1000/100 ml	4000/100 ml	10/100 ml
Clostridia (in water) (35°C)	0/100 ml	4/100 ml	0/100 ml

Raw water samples should be collected at least monthly. The Geometric Mean of sample results should not exceed the values given in the table above.

5 CRITERIA OF WATER QUALITY FOR AESTHETICS AND RECREATION (A & R)

All surface waters should be capable of supporting life forms of aesthetic value. The positive aesthetic and recreational values of water should be attained through continuous enhancement of water quality. Surface waters should be of such quality as to provide for the enjoyment of recreational activities such as hunting and fishing which are based on the utilization or consumption of fish, waterfowl and other forms of life.

The aesthetic and recreational values of unique or outstanding waters should be recognized and protected by development of appropriate water quality standards for each individual case. To retain or establish unspoiled wilderness values, it may be necessary to control access by mechanized methods of transportation.

General criteria for recreation and aesthetic use and specific criteria for total body contact recreation follow:

A & R-1 General Criteria for Recreation and Aesthetics

Surface waters should be free of substances attributable to discharge of waste or land drainage which may impair aesthetic or recreational use, as follows:

- (1) Materials that will settle to form objectionable deposits.
- (2) Floating debris, oil, scum and other matter.
- (3) Substances producing objectionable colour, odour, taste or turbidity.
- (4) Materials, including radionuclides, in concentrations or combinations which are toxic or which produce undesirable physiological responses in humans, fish and other life and plants.
- (5) Substances, including nutrients, and conditions, including temperature, or combinations thereof in a degree or concentration which produces undesirable types or abundance of aquatic life.

A & R-2 Criteria for Total Body Contact Recreation

Surface waters for total body contact recreational use should be free of substances attributable to discharge of waste or land drainage as follows:

- (1) Materials which will cause the pH to change beyond the range 6.5-8.3.
- (2) Materials which will obscure visibility in the water. In designated swimming and diving areas, clarity should be such that a Secchi Disc on the bottom is visible from the surface.
- (3) Conditions which will cause the water temperature to exceed 85°F.
- (4) Microbiological Criteria

Water used for body contact recreational activities should be free from pathogens including any bacteria, fungi or viruses that may produce enteric disorders or eye, ear, nose, throat and skin infections. Where ingestion is probable, recreational waters can be considered impaired when the coliform, fecal coliform, and/or enterococcus geometric mean density exceeds 1000, 100 and/or 20 per 100 ml respectively, in a series of at least ten samples per month, including samples collected during week-end periods.

If these criteria are exceeded, it will become necessary to determine the cause and initiate corrective action.

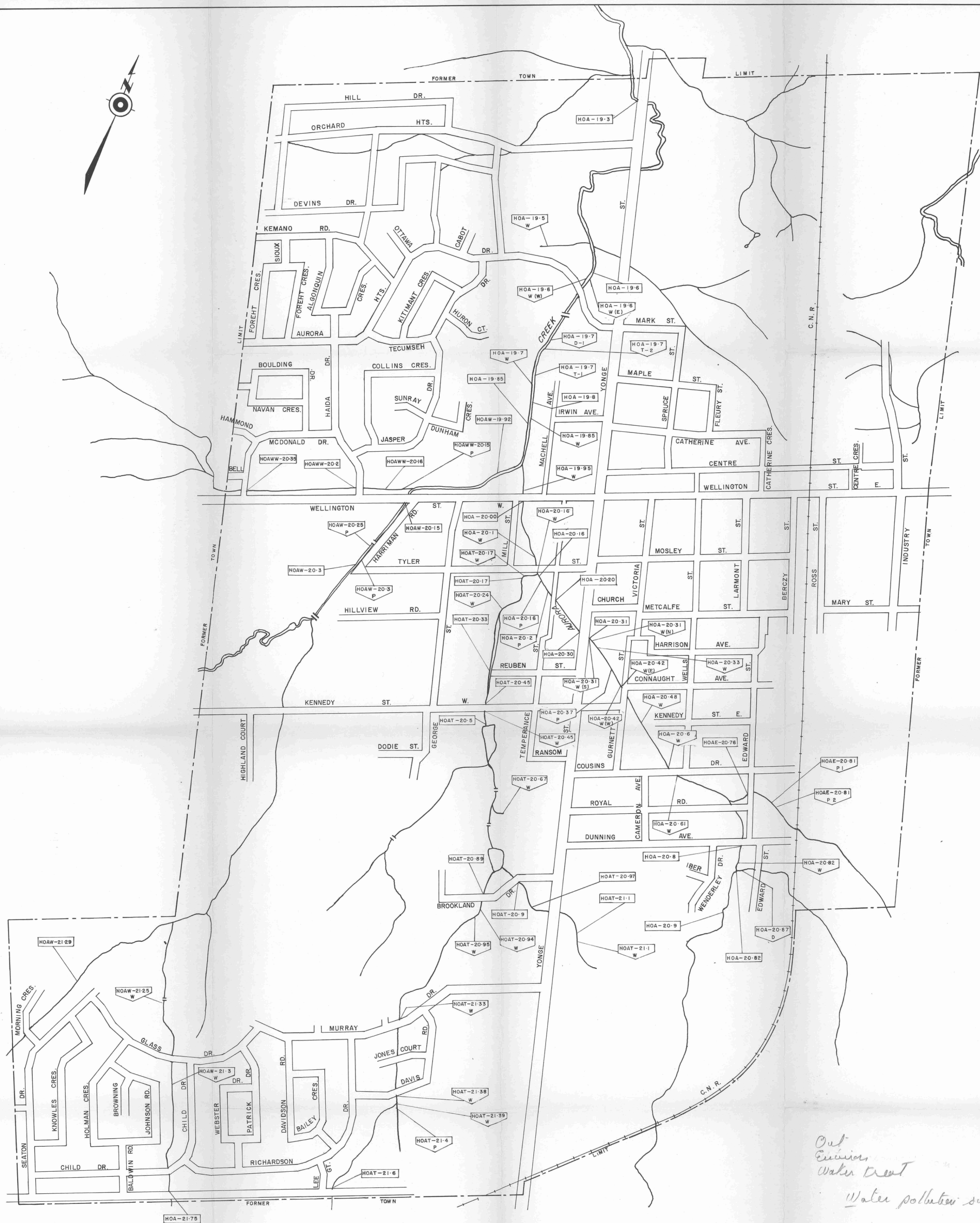
When evaluating a given area of water for recreational use, the appropriate numbers of samples, and the choice of tests to be performed should be determined by consultation between sampler and analyst, prior to sampling. An effort should be made to increase utilization of the fecal coliform and enterococcus tests since these presently appear to be the more relevant guides to the bacterial quality of bathing waters.

GLOSSARY OF TERMS

Bioassay	— A controlled laboratory procedure which subjects live aquatic organisms to various environmental stresses.
Effluent Requirements	— Numerical or verbal descriptions of the quality of a waste or drainage effluent at the point of discharge to a receiving water body, land disposal site or waste disposal well.
Eutrophication	— The increase in the nutrient content of the natural waters of a lake or other body of water.
Geometric Mean	— The n th root of the product of n observations. The equation for the geometric mean (G_x) can be expressed as: $G_x = \sqrt[n]{X_1 \cdot X_2 \cdot X_3 \cdot \dots \cdot X_n}$ or $G_x = \text{antilog} \left(\frac{\log X_1 + \log X_2 + \dots + \log X_n}{n} \right)$
Land Drainage	— Water that has drained from the land surface naturally or through man-made drainage systems.
Milligrams per Litre (mg/l)	— A unit of measure expressing the concentration of a substance in a solution.
Milligram equivalents per litre (mg. eq/l)	— A unit indicating the chemical equivalence of ions; derived by dividing the concentration of an ion in milligrams per litre by the combining weight of that ion. Note: combining weight = $\frac{\text{atomic or molecular weight of ion}}{\text{ionic charge}}$
Oligotrophic	— Waters with a small supply of nutrients and hence a small organic production; usually having abundant dissolved oxygen at all depths.
Photosynthetic (adj.)	— Relating to the process by which the chlorophyll-bearing cells of green plants convert carbon dioxide (CO_2) and water (H_2O) into sugar ($\text{C}_6\text{H}_{12}\text{O}_6$) and oxygen (O_2) in the presence of light.
Raw Water	— Surface or ground water, prior to treatment.
Waste	— Liquid carrying unwanted materials or compounds resulting from human activities or enterprises to a point of discharge. The mixture may or may not have received treatment.
Water Quality Criteria	— Numerical or verbal descriptions of the quality of water required for particular uses.
Water Quality Standards	— Numerical or verbal descriptions of the quality of water required for a variety of uses in a given drainage system.

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D - DRAINAGE DITCH
P - PRIVATE SEWER
T - TREATMENT PLANT EFFLUENT
W - STORM SEWER

Out-
Estuaries
Water Treat

CASON
WR 610
1971
A16
[no.2]

Water pollution survey



TOWN OF AURORA
(URBAN AREA)
WATER POLLUTION SURVEY
1971

SCALE :	
DRAWN BY : L. L. BROOME	DATE : MAY, 1971
CHECKED BY : D. C.	DRAWING N ^o : 71-40-DE



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